telegraph office in the Transvaal for publication on a notice board. Synoptic maps, however, are not published on account of the expense. Altho a large land area lies to the west of the Transvaal, the advantage of this circumstance for weather forecasting is neutralized by the lack of telegraphic meteorological stations in the region in question. However, a daily telegram is received from Swakopmund, German Southwest Africa, giving the height of the barometer. Besides the forecasts for twenty-four hours, seven-day forecasts are occasionally issued.

An Ångström pyrheliometer was added to the equipment of the central observatory during the year. An investigation of the daily amount of chemical radiation from the sun was also undertaken.

Other interesting features of this report are charts showing mean rainfall and mean cloudiness over the Transvaal, based on the records of three years, and a full account of the code used by the observers for weather telegrams.

GERMAN METEOROLOGICAL SOCIETY, HAMBURG, 1908.

The eleventh general meeting of the German Meteorological Society was held at Hamburg September 28–30. The society having reached the twenty-fifth year of its existence, the meeting was regarded as of special interest, and it was attended by a large number of members drawn from all parts of the Empire. In addition, Australia was represented by Messrs. Hunt and Barton, the British Isles by Mr. Harries, France by M. Teisserenc de Bort, Hungary by Hofrat Konkoly, Norway by Vice-Director Aksel Steen, and the United States by Professor Rotch. Professor Hellmann, as president of the society, opened the meeting with a congratulatory speech suitable to the interesting occasion. Admiral Herz, director of the Deutsche Seewarte, was called upon to respond for the official meteorological service; Mr. Harries, as the representative of the Royal Meteorological Society, for the foreign visitors; Professor Dr. Voller for the physical institutions, and Doctor Friedrichsen for the geographical societies. Doctor Hellmann then gave an address on the "Dawn of Meteorology." Subsequently there were five sittings, at which twenty-five papers were discust, the subjects being general meteorology, the meteorology of the upper atmosphere, weather forecasting, and atmospheric electricity. Such an amount of work could only be got thru by steady application from 9 a. m. to 6 p. m. daily. To make up for this the social side of the occasion was not neglected. On Monday night, the 28th, visitors were the guests of the senate of the free town of Hamburg, in the Rathhaus; on Tuesday there was a dinner at the Hamburger Hof; on Wednesday the Hamburg-American Steamship Company took the visitors round the harbor, and on a trip some miles down the Elbe, concluding the excursion with a visit to the liner *König Wilhelm II*. On Thursday the Seewarte and other institutions were thrown open to the visitors, and the afternoon and evening were devoted to the kite and balloon station at Gross-Borstel. The final act of the gathering was a dinner given by Professor and Mrs. Köppen.

It was further announced that MM. Angot and Teisserenc de Bort, Professor Rotch and Doctor Shaw had been elected honorary members of the society.—*Symons's Meteorological Magazine, October, 1908.*

AS TO A DETAILED CLOUD CLASSIFICATION.

Meteorologists are not all of one opinion as to the wisdom of distinguishing and naming subvarieties of the simple types of clouds recognized in the International Classification. Mr. A. W. Clayden, one of the most successful photographers of clouds, recently exhibited some of his pictures at the Franco-British Exposition, and these were labeled in accordance with the elaborate nomenclature proposed in his book "Cloud Studies," published in 1905. They bore such names as cirrus

ventosus, cirrus communis, cirrus inconstans, alto-cumulus castellatus, etc.

In the September number of Symons's Meteorological Magazine Mr. L. C. W. Bonacina criticises these names and expresses the opinion that they do not represent sufficiently well-defined types to be of utility. Beyond the simple names of the International System, he thinks that a description, rather than a name, is needed to indicate clearly the character of the clouds in question. A contrary opinion, however, is exprest by M. Albert Bracke, the editor of la Revue Néphologique, in the October number of the latter journal. M. Bracke declares that the subdivisions of the simple types, which have been described by several cloud specialists, are themselves quite typical, and he himself uses the nomenclatures of Clayden and Vincent, both of which he says are easily learned and enable one to express in a word or two the aspect of the sky at the time of observation.

INSTALLATION OF AUTOMATIC RIVER STAGE REGISTER AT HARTFORD, CONN.

By WM. W. NEIFERT, Local Forecaster. Dated: Hartford, Conn., October 10, 1908.

An event memorable in the annals of Hartford was the "Bridge Celebration" of October 6–8, 1908, it being the dedication and the laying of the last stone of the beautiful and durable granite bridge across the Connecticut, which is about one-fifth of a mile wide, at this place. At the very inception of the designs for the bridge, Government officials saw the advantage of being able to secure automatic records of river stages which would be of special interest and value to the people of Connecticut and incidentally to the inhabitants of the 12,000 square miles of territory drained by the Connecticut River. The gaging of such a noble stream gives important data that are of great interest in meteorological work, as well as of much practical value to water-power plants, farmers, shippers, and the lumbering industry. Thru the courtesy of the Bridge Commission provision was made for the proper accomodation of a river stage register within one of the main-channel piers of the bridge indicated by arrow in fig. 1. The Chief of the Weather Bureau, appreciating the durability of the structure, directed that a register be installed, and this work was completed on September 8, 1908, under the supervision of Mr. D. T. Maring, Assistant Chief Instrument Division, of the Central Office. The register is of the latest improved Friez pattern, operating continuously and automatically and is the only one of the kind in present use in this service.

The gage well.—The bridge pier containing the apparatus has a cylindrical shaft, or well, 4 feet in diameter, reaching from a vault or room immediately under the sidewalk of the bridge down to the bed of the river. Access to the interior of the pier is gained from an iron trap-door in the sidewalk of bridge and a step-ladder to the floor of the vault. The well opening around the pipes is covered by a strong wooden platform with detachable manhole. From the river the water is admitted to this well by a 4-inch pipe extending horizontally from the down-stream outer surface of the pier, and consequently the water in the well rises and falls with any rise or fall of the water outside. Within the well is the gage-float guide, consisting of a 10-inch cast-iron pipe which extends vertically from 3½ feet above the surface of the well to 4 feet below the zero of the gage, where it rests on two short lengths of railroad rail placed on the rock foundation. These rails provide a solid base for the heavy pipe and also an intake for the water, tho to produce a better circulation in and around the lower end, a hole about 5 inches wide and 6 inches long was cut out of the float pipe at a point about 3 feet from the bottom. This large pipe is made up of three 12-foot lengths of cast-iron pipe and a top section of wrought-iron pipe 11 feet long. These four sections are well secured together by packing and cement in the bell-joints, and lined up so as to be perfectly

vertical. To this pipe is attached by special iron clamps 44 feet of 1¼-inch galvanized-iron pipe for the counterweight, also plumbed to be vertical and parallel with the float-pipe.

The registering apparatus.—To the top of the gage-float guide-pipe is screwed a cast-iron flange to which the wooden support of the instrument is fastened in such manner that the sprocket-wheel of the register comes directly over this pipe, as illustrated in fig. 2.

The instrument, with cover case open, is clearly shown in fig. 2. It consists of a metal base on which is mounted the

FIG. 1.— Connecticut River Bridge, Hartford, Conn.[1]   (Looking north.   Main-channel pier, No. 1, indicated by arrow—river-gage in vault at ✗.)
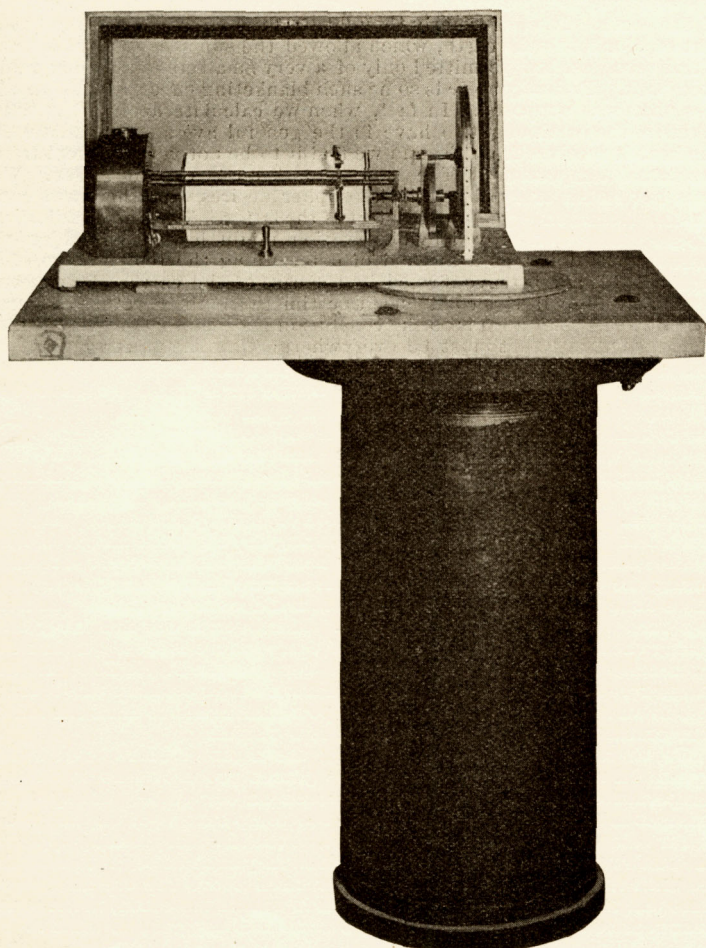

FIG. 2.—Automatic river-gage register, with glass cover raised.
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usual eight-day power clock for propelling a recording-pen carriage by means of a feed-screw. With the clock mechanism is a revolvable record-drum 8 inches long and 12 inches in circumference, which carries the weekly record-sheet. The delicately mounted sprocket-wheel on the right has motion communicated to it by a very light and flexible phosphor-bronze perforated tape or band passing over accurately spaced pins on the circumference of the wheel. The tape is attached at one end to a 7-inch copper float and at the other to a small counterweight running up and down in the smaller pipe. As the water in the shaft rises it carries the float with it, causing the tape to move. This movement of the tape turns the sprocket-wheel, which communicates its motion to the record-drum thru suitable gears having a recording ratio of 1 to 20. One revolution of the drum (or 12 inches) thus equals 20 feet rise or fall of water. The engraved part of the sheet is also 8 by 12 inches, ruled and spaced to indicate hours of time, and feet and fifths of water stage. The perforations of the tape provide for a range from 2 feet below the gage zero to 39 feet above.

As installed the register is fitted with a glass case having lock and key. Over all is placed a rubber sheet to keep out dirt and dampness, and on the outside is attached a notice warning the public not to interfere with the apparatus.

Remarks.—Experience with this installation suggests a word of caution in future installations of this kind. Acting under instructions, the contractors put in only a 4-inch intake pipe between the bottom of the well and the channel outside of

[1]This is the largest stone arch bridge in the world. Total length 1,120 feet, nine spans. Maximum clear height to intrados of arch above low water, 45 feet. Width outside spandrel walls, 82 feet. Clear roadway, 80 feet, viz: Two 10-foot sidewalks and 60 feet between curbs for two carriageways and two street-car tracks. Foundations carried to 50 feet below low water. Weight of largest finished stone used in the construction, about 40 tons. Total amount of masonry in bridge proper, about 100,000 cubic yards. Cement used in construction, about 125,000 barrels. Cost of bridge $1,600,000, and with approaches complete nearly $3,000,000. Chief Engineer, Edwin H. Graves; Deputy Chief Engineer, John T. Henderson; Assistant Engineer, Edward W. Bush.

the pier. This was laid in 1906, and it had become completely filled with sand and silt at the time of installing the register in 1908. This pipe should have been at least 8 inches in diameter, and there should have been another pipe outlet to the channel arranged so there would always be a slight movement of water thru the bottom of the well. Thus the inlets would tend to keep themselves clear. A 2-inch pipe is now in place several feet above the 4-inch pipe, and will, of course, do this to some extent when the water is above that point, but it is feared it will hardly prove sufficient for the purpose, and a special annual cleaning out of the bottom of the well and the lower inlet-pipe may be required.

The 10-inch float-guide pipe was installed in sections as the work of building up the pier progressed, but no special efforts were made to avoid the accidental deposit therein of wood, crusht stone, cement, and filth by careless workmen. Both well and pipe should be kept closed during the building operations of all bridge piers intended for the use of registering river gages. Where possible, more light and ventilation should also be provided for the vault room containing the registering apparatus.

The records thus far obtained at Hartford have been checked daily by eye observations of the ordinary river-gage, and have been found exceedingly accurate. They will doubtless prove of great value in the river work of this section.

THE METEOROLOGY OF MARS.

By Prof. Simon Newcomb. [Reprinted from Harper's Weekly for 25th of July 1908.]

The study of the atmospheres of each of the other planets of our solar system is likely to add something to our knowledge of our own atmosphere, and we commend to our readers the following extract from a longer article by our distinguished colleague in astronomy.—C. A.

There are two points concerning Mars on which we can speak with a fair approach to certainty, and which will be most valuable in enabling us to interpret observations.

In the first place the atmosphere of Mars is so much rarer than that of the earth that the most delicate observations by Campbell with the great spectroscope of the Lick Observatory have failed to show any evidence whatever of its existence. This does not prove that no atmosphere exists, because there are other sources of evidence; but in the opinion of Campbell it shows that the density of the atmosphere can not amount to one quarter that of the earth. This view is strengthened by the comparative rarity of clouds upon the planet. Portions of the surface are seemingly obscured by vapors from time to time, but this is rather exceptional in any one region.

The other point on which we have some light, apart from the revelations of the spectroscope, is that of the probable prevailing temperature. A reliable estimate of this important element in Martian meteorology has been possible only in recent times, since the law of radiation of heat has been determined. The reasoning on which the estimate is based is so simple that I shall venture to set it forth.

We all know that a hot body is continually radiating heat, so that fire in the chimney place will warm the opposite walls of the room even if the air is below the freezing point. We feel this radiation only in case of very hot bodies, like the coals or flame of a fire. But accurate experiments show that every body, however cold it may be, radiates heat when left to itself without receiving heat from any outside source.[1] For example, during the night the earth radiates heat into space hour by hour, so that, as a general rule, its surface grows cooler during the entire night. Exceptions occur only when a current of warm air sets in. We know that, during the polar winter, although the Arctic regions receive a little warm air from the temperate zone, the temperature continually falls through radiation into the sky, month after month, until it reaches a degree far below any ordinarily experienced in our latitudes. It follows that any heat thus radiated by a planet, like the earth or Mars, must be gained from some source, else the temperature will fall below any that we ever experience on the earth, even below that of liquid air.

There is practically only one source from which the necessary heat is derived either for the earth or for a planet. That source is the sun. True, a little heat is received from the stars and a little from the interior of the earth, but these amounts are so small as to be scarcely measurable. Now, suppose a perfectly cold planet like the earth or Mars exposed to the sun's rays, and set rotating on its axis while revolving around the sun

in a regular orbit. It will gradually absorb heat from the sun and so rise in temperature. As the temperature rises, heat will be radiated at a rate which continually increases with the temperature, as we see in the case of the fire. A point will finally be reached at which the amount of heat radiated is equal to the total amount received from the sun. Then the temperature will become stationary. It follows that if we know how warm a body must be in order to radiate a certain amount of heat, and if we know how much heat it receives from the sun, we can approximately determine its temperature.

The sun's radiation upon the earth has been determined with as much certainty as the case admits of by several modern physicists, high among whom stands our late Professor Langley, Secretary of the Smithsonian Institution. The result of these observations may be exprest in the following way. Imagine a flat vessel 1 inch thick, of any cross dimensions, filled with water and covered over water-tight. We thus have something which may be shaped like a very thin box. The main points are that the thickness of the vessel is exactly 1 inch, that it is filled with water, and that one surface is blackened so that it absorbs all the heat which falls upon it. Let this surface be exposed to the rays of the sun as shown in the figure.[2] It is found that the amount of heat falling upon it will suffice to raise the temperature of the water 1° C., that is, about 1.8° F., in a minute. This, then, is the measure of the heat which the sun radiates to a planet as distant as ours. Knowing it for the distance of the earth, we can easily compute it for Mars, because the intensity diminishes as the square of the distance increases. When Mars is nearest the sun each square mile of its surface receives about half as much heat as the earth, and at the greatest distance about one-third as much. This has long been known, but only recently has the other part of the problem been solved—that of determining how warm the earth or Mars must be in order to radiate all the heat it receives. The temperature that is necessary to produce this effect was long greatly underestimated. A curious instance is afforded by Langley's estimate of the temperature of the moon. He supposed that a body radiating as little heat as the moon does must be far below the freezing point. But when the law of radiation was finally established, it was found that Langley's observations showed the temperature of the moon to be not strikingly different from that which prevails on the earth, tho it might be much higher under a noonday sun and much lower when turned away from the sun. Very interesting is the agreement of the computed result with the temperature of the earth. It was formerly thought that the atmosphere served as a sort of blanket to the earth, which allowed the sun's heat to pass thru it and reach us, but permitted only of a very small amount being radiated back. Probably there is some such blanketing effect, but it is much less than was supposed. In fact, when we calculate about what temperature the earth ought to have in the general average, to radiate all the heat it receives from the sun we find it to be not very different from the actual temperature. The same remark applies to the moon. We thus have what every physical philosopher desires when he draws conclusions from a theory—practical test of the latter. The law of radiation, tho seemingly well proved by observation, might have been subject to more or less doubt as a method of determining the temperature of a planet had it not been confirmed by the case of the earth. Being confirmed, we apply it with confidence to estimate the temperature of Mars. A simple calculation leads to the conclusion that the temperature of the surface of that planet must be everywhere below the freezing point of water, unless in its torrid zone, under a high sun.

Another conclusion from the rarity of the air is that the vicissitudes of temperature are there far greater than upon the earth. We have remarked that during our night the earth cools off by radiating into space the heat which it received from the sun the day previous. We also know that the clearer and dryer the air the greater is the fall of temperature, while the presence of clouds lessens the fall by interfering with radiation. The radiation and absorption of heat by the atmosphere are much less than by the earth, so that during the night the air gives back to the earth an important part of the heat which it has received from it during the day. But on Mars the air is so rare that during the night it offers little impediment to the radiation, and does not contain much heat to return to the surface of the planet. Moreover, in our Arctic regions, during the long polar night, the fall of temperature is lessened thru the intercommunication of the air by winds between the Frigid Zone and the warmer regions where the sun is shining. Now on Mars this feature also is wanting, and there is no such powerful agent to limit the fall of temperature in regions where the sun is not shining.

We, therefore, conclude that during the night of Mars, even in the equatorial regions, the surface of the planet probably falls to a lower temperature than any we ever experienced on our globe. If any water exists it must not only be frozen, but the temperature of the ice must be far below the freezing point. When, as the Martian morning appears, the sun's rays shine upon this cold region they can not begin to melt the ice until the temperature of the latter rises above the freezing point. This will take a much longer time than it will on the earth, because the heat received is, on the average, less than half as great as what we receive. Without going into detailed calculations, we may say that it is scarcely possible that more than one or two inches of ice could be melted

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[1] The law followed is that the higher the temperature of a body the more rapidly it loses heat by radiation.

[2] Not reproduced here.